Work Plan for
Community Risk Assessment
The Doe Run Company
Herculaneum, Missouri

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1 Overview

This document presents a work plan for performing a baseline human health risk assessment for the community of Herculaneum, Missouri (henceforth referred to as the "Community Risk Assessment"). The risk assessment will be performed under the Administrative Order on Consent (AOC) between Missouri Department of Natural Resources (MDNR) and Doe Run Resources Corporation (DRRC) dated May 21, 2001. In the Statement of Work (SOW) for the AOC, Section I.1.D requires that a human health risk assessment be conducted following the completion of the soil characterization. The risk assessment will be conducted according to USEPA Risk Assessment Guidance for Superfund (RAGS) Volume I: Human Health Evaluation Manual (Part A) (USEPA, 1989).

The primary contaminant of concern for this community is lead. The objective of the Community Risk Assessment is to assess health risks from exposure to constituents (primarily lead) in soil, house dust, street dust, and air in Herculaneum, Missouri. The results of this evaluation will be used to develop soil cleanup levels that are protective of both adults and children.

1.1 Site Background

The Doe Run Resources Corporation (DRRC) operates a primary lead smelter in Herculaneum, Missouri. Elevated levels of lead in soil are found in residential soils in the neighborhood of the facility. On April 26, 2002, in response to the Missouri Department of Natural Resources' (MDNR) concern about elevated lead levels in residential soils near the facility, DRRC agreed to offer to purchase all of the residential properties within a boundary that is approximately within 3/8 mile of the facility. The boundary of the purchase area (referred to in this work plan as the Voluntary Property Purchase (VPP) Area) was decided in conjunction with the MDNR in April 2002 (Figure 1). Properties within the VPP area are being considered for lease to individuals without children.

By July 2002, Doe Run had completed implementation of new emissions controls at the facility designed to reduce air lead emissions and comply with the State Implementation Plan (SIP). DRRC has proposed establishing a buffer zone within the VPP area that would encompass the houses nearest the plant. It is currently planned that houses within the buffer zone will remain unoccupied and will eventually be either removed to create a greenspace area or be incorporated into the plant. The boundary of the proposed buffer zone is shown on Figure 1, but may be adjusted as part of the risk assessment analysis.

2 Exposure Pathways and Receptors

Risks will be evaluated in a total of five exposure areas. The exposure areas and potential receptors to be evaluated in the risk assessment are discussed in the sections below and are summarized in Table 1.

Table 1
Exposure Pathways and Receptors

Exposure Area	Receptors	Media	Exposure Pathways
Inside VPP Area	Adult Resident Child Visitor	Surface soil (0-1") House Dust Street Dust ??	Ingestion
		Air	Inhalation
Outside VPP Area	Adult Resident Child Resident	Surface soil (0-1") House Dust Street Dust	Ingestion
		Air	Inhalation
Residential Area downwind of Slag Storage Area (Within VPP Area)	Adult Resident Child Visitor ??	Surface soil (0-1") House Dust Street Dust	Ingestion
		Air	Inhalation
Buffer Zone	Adolescent Recreator Adolescent Trespasser (13-18 yr) → 7-16 yrs old	Surface soil (0-1")	Ingestion
		Air	Inhalation
Slag Storage Area	Adolescent Trespasser (13-18 yr)	Surface soil (0-1")	Ingestion
		Air	Inhalation

— why not child resident??

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why not residential as well?

2.1 Residential Area Inside Voluntary Property Purchase Area

For residential properties inside the VPP area, we will evaluate an adult resident in order to evaluate whether adults without children have any excess risk at properties within the VPP area after the property purchases are completed. The adult resident is assumed to have an exposure frequency of 350 days/year. We will also evaluate a child visitor who visits the VPP area 1-2 days/week. — follow EPA's draft IE guidance (why just 1-2 days?) 5a

The ages of the adult and child receptors are different for lead than for other COPCs. For evaluation of lead, USEPA considers the appropriate adult receptor to be a woman of child-bearing age (USEPA 1996), assumed to be between the ages of 20 and 49 years old. In addition, the child age is 6 to 84 months, the age range used in EPA's IEUBK model. For non-lead COPCs, an exposure duration must be specified. The child is considered to be ages 0 to 6 years, with a 6 year exposure duration. Two exposure durations will be evaluated for the adult. ~~One will be a long-term resident with a 24-year~~ exposure duration, and the oth~~er will be a short-term resident~~ with a 2-year exposure duration. The child visitor will be evaluated for a 6-year and a 2-year exposure duration. — what is the basis for this? 5b

5c

To evaluate current risks, the adult resident and child visitor are assumed to be exposed to soil, housedust, and street dust *via* incidental ingestion, and to air *via* inhalation. Humans have incidental soil

What is the basis for this!

6a & 6b

ingestion while performing typical daily activities, such as eating or touching their mouths. It will be assumed that the adult and child obtain 10% of their daily soil/dust ingestion from street dust. The risk assessment will use a relative bioavailability of 30% for lead in soil, 1% for street dust, and 1% for material from the slag storage area. no basis for this!!

A future scenario will also be evaluated. The future scenario assumes that a bridge will be constructed at one end of town that eliminates the need for the lead ore concentrate to be transported through town, which will presumably eliminate street dust derived from lead ore concentrate. Thus, under the future scenario, it is assumed that there will be no exposure to street dust. The adult resident and child visitor are assumed to be exposed to soil and housedust *via* incidental ingestion, and to air *via* inhalation. See Bruce ?? 6c

The adult is assumed to breathe the air concentration at his/her residence for 24 hours per day. The air concentration at a given residence will be assigned based on the results of the post-SIP air modeling, rather than on the actual post-SIP air data. The reason for this is that the post-SIP air modeling assumed that the Doe Run facility was operating at full capacity, whereas the air monitoring data were collected during a period when the facility was operating at only about 75% of full capacity. Thus, use of the post-SIP air modeling data represents a conservative estimate of air concentrations. must not be less than air monitoring data 6d

push this into air monitoring data

Dermal contact with lead in soil will not be evaluated as lead uptake from dermal contact is very low. The USEPA Dermal Risk Assessment Guidance (USEPA, 2001) does not list a dermal absorption value for lead, and states that there are "no default dermal absorption values for … inorganic classes of compounds" (USEPA, 2001; p. 3-24). Blood lead models used by USEPA for lead risk assessment do not include a component for dermal contact. Dermal contact will be evaluated for constituents other than lead, such as arsenic, if they are selected as COPCs in surface soil, and they have published dermal absorption values in USEPA (2001).

2.2 Residential Area Outside Voluntary Property Purchase Area

See Bruce

For residential properties outside the VPP area, an adult and child resident will be evaluated. The adult and child resident are assumed to have an exposure frequency of 350 days/year. The age of the adult and child receptors will be as discussed in Section 2.1. Exposure durations will be 6 years for the child and 24 years for the adult.

data to support this??

To evaluate current risk, the adult and child resident are assumed to be exposed to soil, housedust, and street dust *via* incidental ingestion, and to air *via* inhalation. The adult and child resident are assumed to breathe the air concentration at their residence 24 hours per day. It will be assumed that the child obtains 10% of his daily soil/dust ingestion from street dust. Air lead concentrations will be determined from the results of the post-SIP air modeling.

A future scenario will also be evaluated. The future scenario assumes that a bridge will be constructed at one end of town that eliminates the need for the lead ore concentrate to be transported through town, which will presumably eliminate street dust derived from lead ore concentrate. Thus, under the future scenario, it is assumed that there will be no exposure to street dust. The adult and child resident are assumed to be exposed to soil and housedust *via* incidental ingestion, and to air *via* inhalation.

use it

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2.3 Residential Area North of Slag Storage Area

use site-specific area
basis needs to be made a separate area or not

The slag storage area for the Doe Run facility is located at the south end of town. The residential area located just to the north of the slag storage area will be evaluated as a separate exposure area, as this area is preferentially affected by wind-blown dust from the slag. The boundary of this area will be established by air modeling.

Sampling results should support this

X

Because this exposure area lies within the VPP area, an adult resident and child visitor will be evaluated in this area. The adult is assumed to have an exposure frequency of 350 days/year. The child is assumed to visit 1-2 days/week. The age of the adult and child receptors, and their exposure durations, will be as discussed in Section 2.1.

To evaluate current risks, the adult and child are assumed to be exposed to soil, housedust, and street dust *via* incidental ingestion, and to air *via* inhalation. The adult is assumed to breathe the air concentration at his residence 24 hours per day. It will be assumed that the adult and child obtain 10% of their daily soil/dust ingestion from street dust. **

A future scenario will also be evaluated. ~~The future scenario assumes that a bridge will be constructed at one end of town~~ that eliminates the need for the lead ore concentrate to be transported through town, which will presumably eliminate street dust derived from lead ore concentrate. Thus, under the future scenario, it is assumed that there will be no exposure to street dust. The adult and child are assumed to be exposed to soil and housedust *via* incidental ingestion, and to air *via* inhalation. **

2.4 Buffer Zone

need to evaluate residential exposure as well

As noted in Section 1, in July, 2002, Doe Run completed implementation of new emissions controls at the facility in order to reduce air lead emissions and comply with the State Implementation Plan (SIP). DRC has announced that it will establish a buffer zone within the VPP area that will encompass the houses nearest the plant. Houses within the buffer zone will remain unoccupied. Two receptors will be evaluated in this area: an adolescent recreator (age 13-18 yr) assuming the area remains unfenced; and an adolescent trespasser (age 13-18 yr) assuming the area is fenced. Both receptors will be evaluated for contact with soil *via* incidental ingestion and inhalation of ambient air. The primary difference between these receptors is that the recreator is assumed to be exposed more frequently that is a trespasser. Exposure frequencies will be 1 day/week for the adolescent trespasser and 2 days/week for the adolescent recreator. 39

basis for this?? 8b

2.5 Slag Storage Area

The slag storage area for the Doe Run facility is located at the south end of town and is currently fenced. Direct contact with the slag storage area will be evaluated for an adolescent trespasser (age 13-18 yr) who is assumed to ride a bicycle or all-terrain vehicle (ATV) in the vicinity of the slag storage area. Exposure pathways include incidental ingestion and inhalation of air. If air monitoring data are not available for the slag storage area, the modeled air concentration at the slag storage area will be used. An exposure frequency of 1 day/week will be used for the adolescent trespasser. 3c

follow EZ guidance → nature of exposure

3 Selection of Chemicals of Potential Concern (COPCs)

Lead will be retained as a COPC in soil, street dust, housedust, and air. Other potential COPCs include arsenic, cadmium, nickel, and zinc. In order to screen for other COPCs in soil, the maximum concentration in soil will be compared to the USEPA Region 9 Preliminary Remediation Goals (PRGs), presented in Table 2. The PRG for arsenic is less than Missouri background levels. Therefore, the proposed screening value for arsenic is 16 mg/kg, which is the calculated 95th percentile concentration for Missouri background surface soil (Dragun and Chiasson, 1991). If the maximum concentration exceeds the PRG, the constituent will be retained as a COPC in soil for all exposure areas. follow EPA's background guidance document

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Table 2
Soil Screening Levels

Compound	Soil Screening Level (mg/kg)	Basis
Arsenic	16*	95th percentile for Missouri background
Cadmium	37	Region 9 PRG
Nickel	1560	Region 9 PRG
Zinc	23,000	Region 9 PRG

4 Lead Risk Characterization

Children's exposure to lead will be assessed using the Integrated Exposure and Uptake Biokinetic (IEUBK) Model (USEPA, 1994; USEPA, 2002). The IEUBK Model is a computer-based deterministic simulation that estimates the blood lead concentration in children resulting from their exposure to lead in soil, dust, drinking water, diet, and air. Specifically, the model estimates the intake and uptake of lead into the body and then uses biokinetic modeling to predict blood lead levels. Because of variations in behavior and physiology among individual children, different children will have different blood lead levels, even if they are exposed to the same environment. The IEUBK Model addresses this by treating its central estimate of blood lead concentration (averaged over childhood from age 0 to 7 yrs) as a geometric mean (GM) of a lognormal distribution among similarly exposed children. A default GSD of 1.6 is used to calculate the proportion of children in the variable population falling above 10 μg/dL.

The USEPA adult lead model (USEPA, 2003) will be used to evaluate risk from exposure to lead for adults and adolescents. The model considers women of child-bearing age as the most sensitive receptor to determine the potential health effects from exposure to lead at the site. The model was developed by USEPA's Technical Review Workgroup for Lead specifically for adult exposure scenarios. The USEPA adult lead model will be used to generate an estimate of the geometric mean blood lead levels (μg/dL) in women of child-bearing age, and the geometric standard deviation (GSD) will be used to calculate the 95th percentile blood lead level. Exposure point concentrations (EPCs) will be the arithmetic mean concentration of lead in soil for each property or exposure area. The most recent NHANES data for the Midwest will be used to specify the baseline blood lead level and GSD for both adolescents and adults for use in the Adult Lead Model. If predicted 95th percentile blood lead levels exceed 11 µg/dL[1] for adults or 10 µg/dL for adolescents, an acceptable soil lead concentration will be calculated according to the equation presented in USEPA (2003).

5 Risk Characterization for Non-Lead Constituents

5.1 Exposure Assessment

Exposure is indicated by the total amount of a chemical absorbed into the body (*i.e.*, the dose typically in mg/kg/day), *via* ingestion and dermal contact. The generalized equation for calculating chemical intakes (for constituents other than lead) is shown below (USEPA, 1989):

$$I = \frac{C \times CR \times EF \times ED}{BW \times AT}$$

where:

I	=	Intake (mg/kg body weight/day)
C	=	Exposure Point Concentration (mg/kg soil)
CR	=	Contact rate, the amount of affected medium contacted per unit time or event, *e.g.*, soil ingestion rate (mg/day)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (yr)
BW	=	Body weight (kg)
AT	=	Averaging time (days)

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Submit these to Region VII before proceeding further!

Appropriate values for exposure parameters will be obtained from the following guidance documents:

- USEPA Exposure Factors Handbook Volumes I - III (EPA/600/P-95/002Fc). August 1997.
- US EPA, Office of Emergency and Remedial Response. Risk assessment guidance for Superfund (RAGS). Volume I: Human health evaluation manual. Part E, Supplemental guidance for Dermal Risk Assessment, Interim. EPA/540/R/99/005. September 2001.

Exposure point concentrations will be the 95% upper confidence level on the mean (95%UCL) concentration or the maximum detected concentration ~~within each exposure area,~~ whichever is lower. EPCs for residential soils will be calculated for the whole exposure area, rather than by property.

?? NOT to RELEVANT EXPOSURE UNIT

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[1] A comparison value of 11 µg/dL is derived from the USEPA/Centers for Disease Control and Prevention (CDC) level of concern (10 µg/dL), divided by the maternal/fetal blood ratio of 0.9 (USEPA, 1996).

5.2 Risk Characterization

Hazard Quotients (HQs) will be estimated for arsenic by dividing the average daily intake by the chemical-specific RfD. Total HI values will be estimated for each exposure area to support future remedial action decisions.

Excess Lifetime Cancer Risks (ELCRs) will be estimated for arsenic by multiplying the average daily intake by the chemical-specific cancer slope factor (CSF). A total ELCR value will be calculated for each potentially exposed population by summing the pathway-specific ELCRs. Total ELCR values will be estimated for each exposure area to support future remedial action decisions.

6 Uncertainty Analysis

6.1 Non-Lead COPCs

For COPCs other than lead, the uncertainty analysis will involve a qualitative description of uncertainties associated with each component of the risk analysis, including environmental sampling data, estimation of site exposures, derivation of toxicity values, or other site-specific factors which tend to over- or under-estimate risk.

6.2 Lead Uncertainty

The risk assessment will include a quantitative assessment of uncertainties in predicted blood lead levels and associated lead risk. One source of uncertainty in the IEUBK model is due to uncertainty in the true level of lead exposure that humans receive from soil and other environmental sources. This in turn is due to uncertainty in environmental concentrations and human intake parameters. 11

IEUBK model predictions that are based solely on default input values may be highly uncertain, because it is not possible to evaluate how closely the default values describe the actual community under consideration. The risk assessment will include a quantitative evaluation of the uncertainty associated with model predictions by running the model with alternate or site-specific inputs, and comparing the model predictions to the observed blood lead levels in the community.

The risk assessment will discuss uncertainties associated with five of the model input parameters: relative bioavailability, dietary lead intake, soil ingestion rate, soil-to-dust transfer coefficient, and GSD. Three of these parameters, relative bioavailability, dietary lead intake and soil ingestion rate, are used in calculating predicted blood lead levels. The other two parameters, soil-to-dust transfer coefficient and GSD, are used in calculating site-specific action levels. The risk assessment will evaluate plausible alternative values for these parameters, based on recent literature or site-specific data. The risk assessment will include the results of the IEUBK modeling conducted using alternative input values and will present soil lead action levels calculated using the alternate model input values.

EPA has comments on all of these parameters before at many sites where Gradient has developed → do not believe there is a basis for Δing these!!

MUST use draft report on BIOAVAILABILITY
which is VALID — regardless of whether the ... considers it "DRAFT"
already conveyed on the parameter!

12a

6.2.1 Bioavailability

USEPA recommends a value of 60% for the amount of soluble lead in soil, which is also termed the relative bioavailability of lead in soil. The bioavailability of lead in soil depends on soil type and the sources of lead. In Herculaneum, the lead in soil may come from various sources, including the lead ore concentrate used as raw material by DRC, smelter emissions, and lead-based paint. These sources of lead may have different relative bioavailabilities; for example, the relative bioavailability in the lead ore concentrate was found to be approximately 1% (Drexler, 2001).

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6.2.2 Soil Ingestion Rate

The contribution of the soil ingestion rate to blood lead levels is specified in the IEUBK Model by a set of age-dependent soil ingestion rates. (The term "soil ingestion rate" here refers to the combined intake of both soil and dust.) Recent literature suggests that child soil ingestion rates may be lower than the default values in the IEUBK model. The risk assessment will provide a review of recent literature and assess the impact of alternate values for the soil ingestion rate on predicted blood lead levels. 13

free to do so, but is not conveying site-specific data

6.2.3 Dietary Lead Intake

The contribution of dietary lead to blood lead levels is specified in the IEUBK Model by a set of age-dependent daily dietary intake values. The Lead Guidance Manual (USEPA, 1994) describes that the default dietary lead intake values are based on U.S. Food and Drug Administration (FDA) Market Basket samples that combine lead concentrations in food with average food consumption rates for various food groups. The default values are based on average lead concentrations measured between the fourth quarter of 1986 and third quarter of 1987. Recent literature suggests that current dietary lead intakes in the U.S. are lower than the default values in the IEUBK model. The risk assessment will provide a review of recent literature and derive alternate values for dietary lead intake. 14 → See FAQ — use these data

6.2.4 Blood Lead Geometric Standard Deviation (GSD)

The IEUBK model uses a default blood lead geometric standard deviation (GSD) of 1.6. A site-specific GSD will be derived for Herculaneum if an adequate data set is available. Assessment of a site-specific GSD depends on the existence of a data set that includes blood lead levels, soil ~~lead and dust lead~~ concentrations on a residence-specific basis for a substantial number of ~~children~~. If there are inadequate data available for Herculaneum, the risk assessment will summarize site-specific values used at other sites and will ~~use an alternate values~~ in the risk uncertainty calculations. 15

If data are unavailable — 127 sees no point in using values from other sites

6.2.5 Adult Lead Absorption

USEPA recommends a value of 60% for the amount of soluble lead in soil, and a value of 20% for the fraction of soluble lead absorbed into the body, hence an absolute absorption fraction (absorption

20% represents meal-weighted value for meal-weighted lead   must be age-specific factor) of 12% (20% x 60%) (USEPA, 2003). However, the absorption of soluble lead in adults varies depending on the degree of fasting.

Based on current literature, a value of 8% may be most appropriate to describe the absorption of soluble lead in adults who consume 2 to 3 meals per day, *i.e.*, a meal every 5-6 hours, and thus who are not in a state of fasting when lead is ingested (Bowers and Cohen, 1998; James *et al*., 1985; Maddaloni *et al*., 1998); whereas the 20% value may be more appropriate to describe absorption in individuals who have incidental lead ingestion ~~on an empty~~ stomach. To assess uncertainty in adult lead risks, we will use an alternate value for the absolute absorption fraction of 8% x 60%, or 4.8%. No!! 16

Call Mark

6.2.6 Predicted Blood Lead Levels Using Alternate Exposure Parameter Values

In order to provide a quantitative assessment of uncertainty, blood lead levels for adults and children will be modeled using the alternative values for the input parameters described above. The risk assessment will also present soil lead action levels calculated using the alternate model input values.

7 Derivation of Site-Specific Soil Lead Cleanup Level

A range of soil lead cleanup levels will be derived for each exposure area, based on the IEUBK Model with site-specific and alternate literature values. Cleanup levels that are protective of children will be shown to be protective for women of child-bearing age. The adult lead model will be used to derive acceptable residential soil lead levels for areas without child receptors, such as the VPP area and the slag storage area. The soil lead cleanup levels will use a target 95th percentile adult blood lead level of 11.1 µg/dL for adults and 10 µg/dL for adolescents. The soil lead cleanup level in the VPP area ~~will be shown to be~~ protective of a child who might visit the area one to two days per week. ~~We~~ will also assess the effect of phosphate amendment, which decreases the bioavailability ~~of lead~~ in soil, on the site-specific soil lead cleanup levels. The effect of phosphate amendment on soils will be evaluated from published literature. 17

Cleanup levels for COPCs other than lead will be calculated if a target cancer risk in the range of 10^{-6} to 10^{-4}, or an HI of 1, is exceeded.

NOT PART OF THE BASELINE RISK ASSESSMENT

submitted under separate risk assessment

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8 References

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